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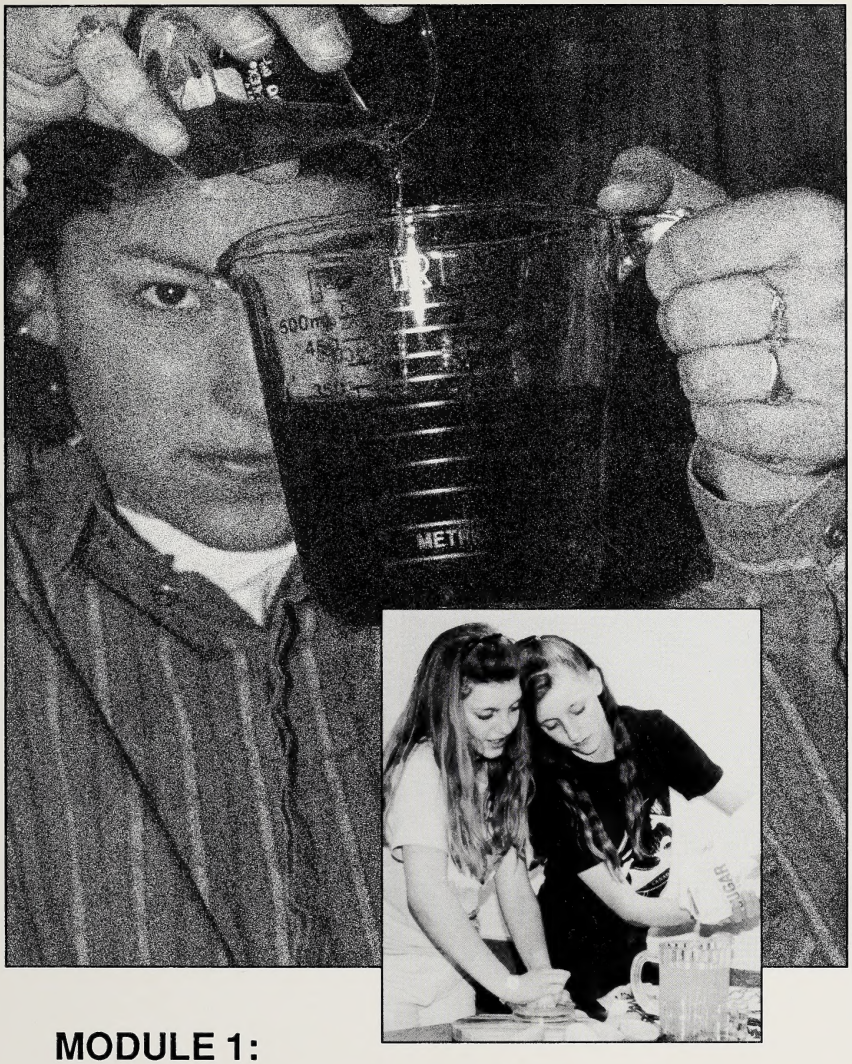
SCIENCE 8



MODULE 1:
Solutions and Substances

STUDENT SUPPORT GUIDE

Distance Learning

Alberta EDUCATION

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Science 8

Module 1

STUDENT SUPPORT GUIDE

Alberta
EDUCATION

Note to the Parent or Guardian

This Science Student Support Guide contains answers to activities in the accompanying Module Booklet. It should be kept secure by the parent or guardian if the student is under 16 years of age. Younger students should not have access to this Guide except under supervision.

This Student Support Guide does not contain the answers to the accompanying Assignment Booklet. The Assignment Booklet will be graded by the student's distance education teacher.

Science 8
Student Support Guide
Module 1
Solutions and Substances
Alberta Distance Learning Centre
ISBN No. 0-7741-0240-3

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COURSE SURVEY FOR SCIENCE 8

FOREWORD

Welcome to distance learning. You have chosen an alternate form of learning that allows your student greater freedom in some ways than traditional classroom learning. It also requires discipline and motivation for your student to carry on without someone standing behind and pushing as a classroom teacher often does. For junior high students distance learning is generally more effective if there is a learning facilitator. A parent or guardian of a student studying at home can be this person. As the learning facilitator, you will have to help motivate and discipline your distance learning student.

This guide has been developed to assist you. It begins by familiarizing you with the process of learning at a distance. You will learn what is expected of a learning facilitator, how the course is set up, and how to help your student complete the course successfully. The remainder of this guide and all other guides (there is one for every module) contain guidance and answers to the activities your student is expected to do. Begin by reading the introductory material in this guide.

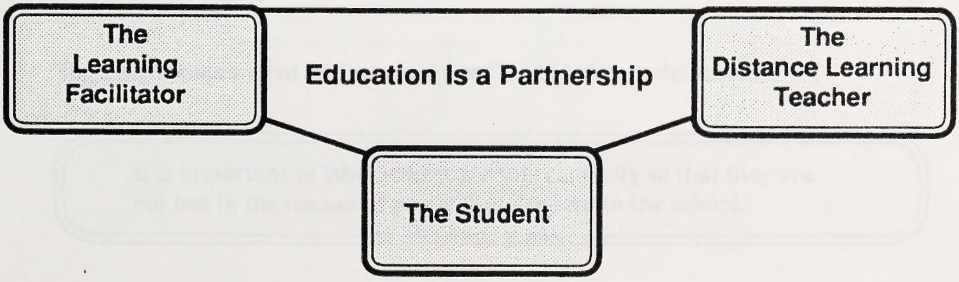
DISTANCE LEARNING

The Role of the Learning Facilitator

As the learning facilitator, you have a key role in determining the success your student has taking this course. Students need encouragement and the confidence of knowing that the course is important to their future.

You are expected to perform the following duties:

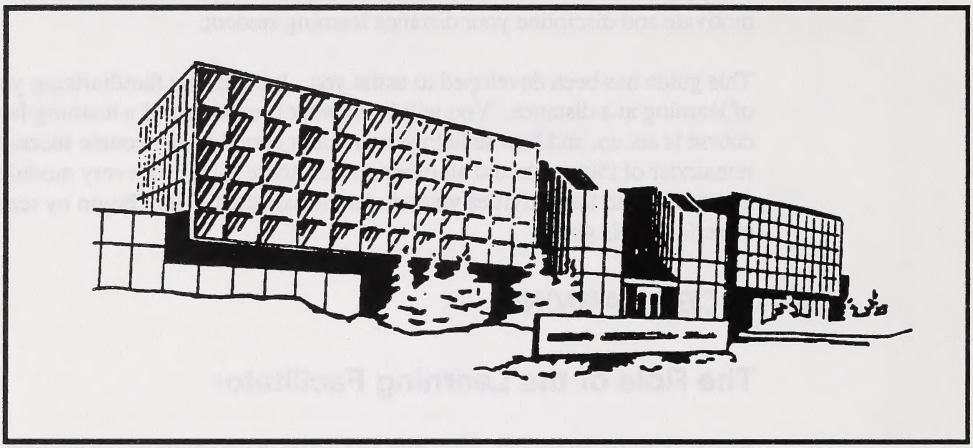
- Be the contact person with the Alberta Distance Learning Centre.
- Ensure the student has a suitable study area.
- Ensure the safe handling of media.
- Ensure the student establishes a timetable.
- Supervise the student's completion of modules.
- Monitor the student's progress.
- Provide the student with encouragement.
- Check the student's work, or supervise the student's checking of the activities.
- Supervise the submission of assignments.



The Alberta Distance Learning Centre

The Alberta Distance Learning Centre helps those who want to learn at a distance.

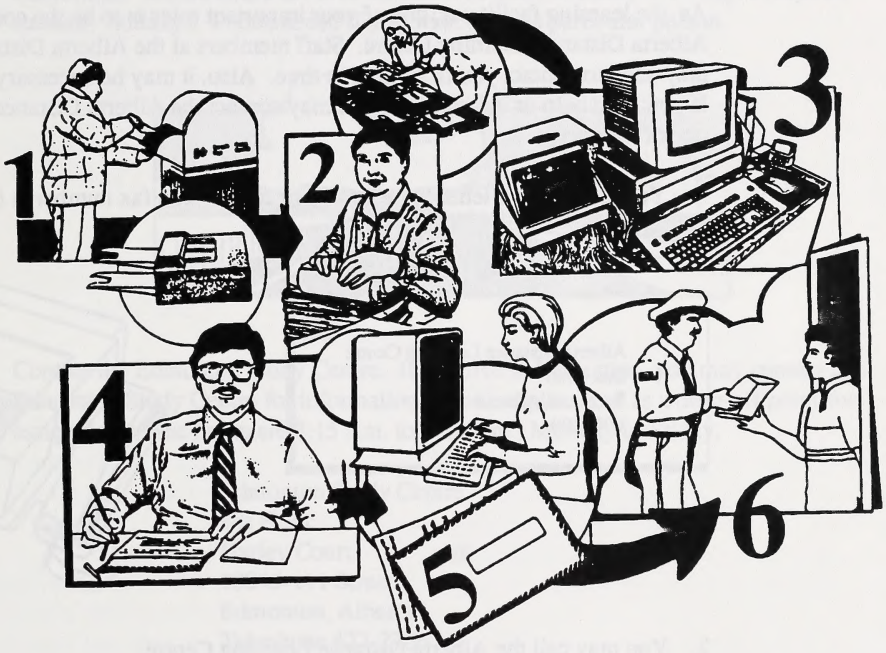
The Alberta Distance Learning Centre



The Alberta Distance Learning Centre is a branch of Alberta Education. It helps educate approximately 40 000 students a year from all parts of Alberta, the rest of Canada, and all over the world. Not all of these students study on their own. Some students use distance learning courses to work at their own pace but work in schools or institutions under the guidance of a learning facilitator. The Alberta Distance Learning Centre provides materials for grades 1 to 9, for the core subjects in high school, and for many option courses. All courses follow Alberta curriculum guidelines.

The building, located in Barrhead, Alberta, is about 6 500 m^2. Barrhead is located 120 km northwest of Edmonton. It contains a modern printing and typography unit, an instructional design unit, a teaching unit, a shipping and mailing unit with its own postal code, and a student services unit. The staff numbers about 200. Some teaching staff work in their homes on a contract basis.

How the Assignments Are Processed



1. Your student's assignments are received at the Mailing Department and sent to the Recording Department.

2. At the Recording Department materials are separated and labels are checked to see that they are correct. Assignments are sorted into elementary, junior high, and senior high subject areas.

3. All assignments and tests are entered into the computer.

4. Depending on the teacher to whom the student is assigned, the student's assignments come to the in-house teachers at the Alberta Distance Learning Centre or go to the contract teachers who work at home.

5. Corrected assignments are returned to the Recording Department. The marks are entered into the computer.

6. The assignments are put into envelopes and mailed back to the students.

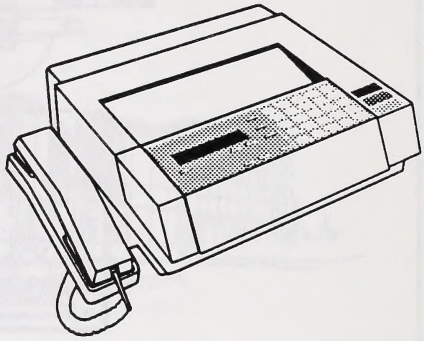
It is important to label your materials carefully so that they are not lost in the masses of paper that are sent to the school.

How to Make Contact

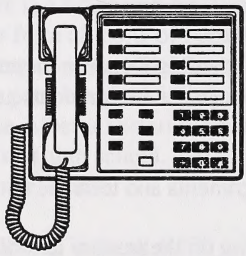
As the learning facilitator, one of your important roles is to be the contact person with the Alberta Distance Learning Centre. Staff members at the Alberta Distance Learning Centre may need to contact you from time to time. Also, it may be necessary for you to contact us. If you need help or information, you may contact the Alberta Distance Learning Centre in one of four ways.

1. You may write a letter to be mailed or faxed. The fax number is 674-6588.

Alberta Distance Learning Centre
Box 4000
Barrhead, Alberta
T0G 2P0

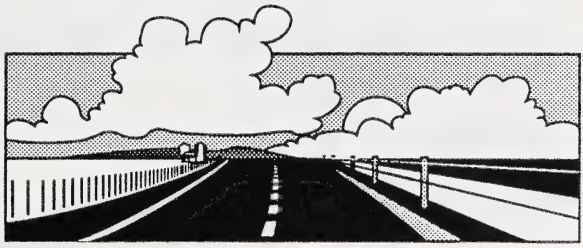


2. You may call the Alberta Distance Learning Centre.



- If you live in the Barrhead area, call 674-5333.
- If you live in other parts of Alberta, you may phone using the Government RITE System. Dial the number of the RITE Operator under your local Government of Alberta listings and ask for the Alberta Distance Learning Centre (674-5333).
- If you live in an area of Alberta not serviced by the RITE Sytem, simply dial "0" and ask for "ZENITH 22333"; then ask for the Alberta Distance Learning Centre.

3. Come to visit the Alberta Distance Learning Centre in Barrhead (120 km northwest of Edmonton). Office hours are 8:15 a.m. to 4:30 p.m., Monday to Friday, except on statutory holidays. Phone ahead if you wish to see a particular person.



4. Contact the Edmonton Study Centre. If you live in Edmonton, you may contact the Edmonton Study Centre for information, some supplies, and as a drop-off point for assignments. The hours are 8:15 a.m. to 4:30 p.m., Monday to Friday.

Edmonton Study Centre
9th Floor
Harley Court
10045-111 Street
Edmonton, Alberta
Telephone 427-2766

When you are concerned about course content, ask for a specific teacher or a particular department. When you are concerned about registrations, testing, or accounts, ask for Student Services.

Student

Student

Teacher

Student Services

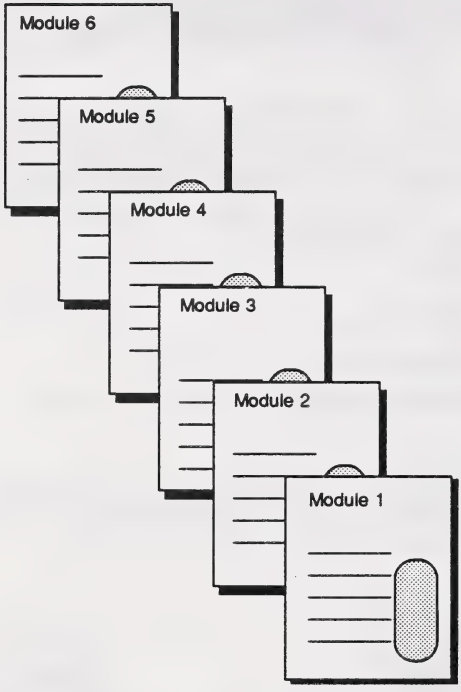
Registrations

ALL ABOUT SCIENCE 8

How the Course Is Designed

This new learning package involves many other components in addition to the student support guide.

Modules

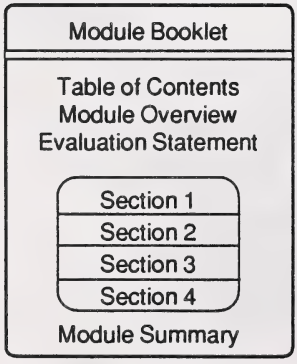


The print components involve booklets called modules.

The structure of the modules in Science 8 follows a systematic design. Each module begins with a table of contents, a module overview, and an evaluation statement.

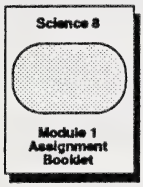
The body of the module is made up of closely related sections. The number of sections will vary from module to module, but each section contains student activities that develop strategies, knowledge, and skills centred around a theme.

At times the student and the learning facilitator are allowed to choose the activity that best suits the student's needs and interests. Other activities are optional. This flexibility caters to each student's personal situation.



The module summary focuses on the main ideas that the student has learned. This is an important part of the module because it discusses how all the ideas in the sections are related.

Assignment Booklets



Accompanying each module is an assignment booklet. The student's mark for each module will be determined by how well they do the assignments in the assignment booklet. If they are having difficulties, they should go back and review the appropriate section in the module booklet. Students are directed to the assignment booklet while working through the module booklet. The assignments usually follow several activities in the module booklet.

There are a number of assignments in the assignment booklet. The total of these assignments is 100 marks.

When the student has completed the assignment booklet, it should be promptly mailed for corrections to the Alberta Distance Learning Centre. While you are waiting for feedback from the teacher, you are encouraged to have the student start the next module.

Media

VIDEOCASSETTE

The learning package also includes reference to media. Pathways have been developed so students can use a variety of media to learn what is important. These different routes have been included to suit different learners. Wherever videos have been included, a print pathway is also available. This way, if the media isn't available or desired, a student can follow the print pathway and still successfully complete the course.

COURSE AUDIOCASSETTE PROVIDING GENERAL TEACHER GUIDANCE

A special audiocassette features a teacher guiding the student through the course. The appearance of the teacher icon reminds students that there is this additional help available.

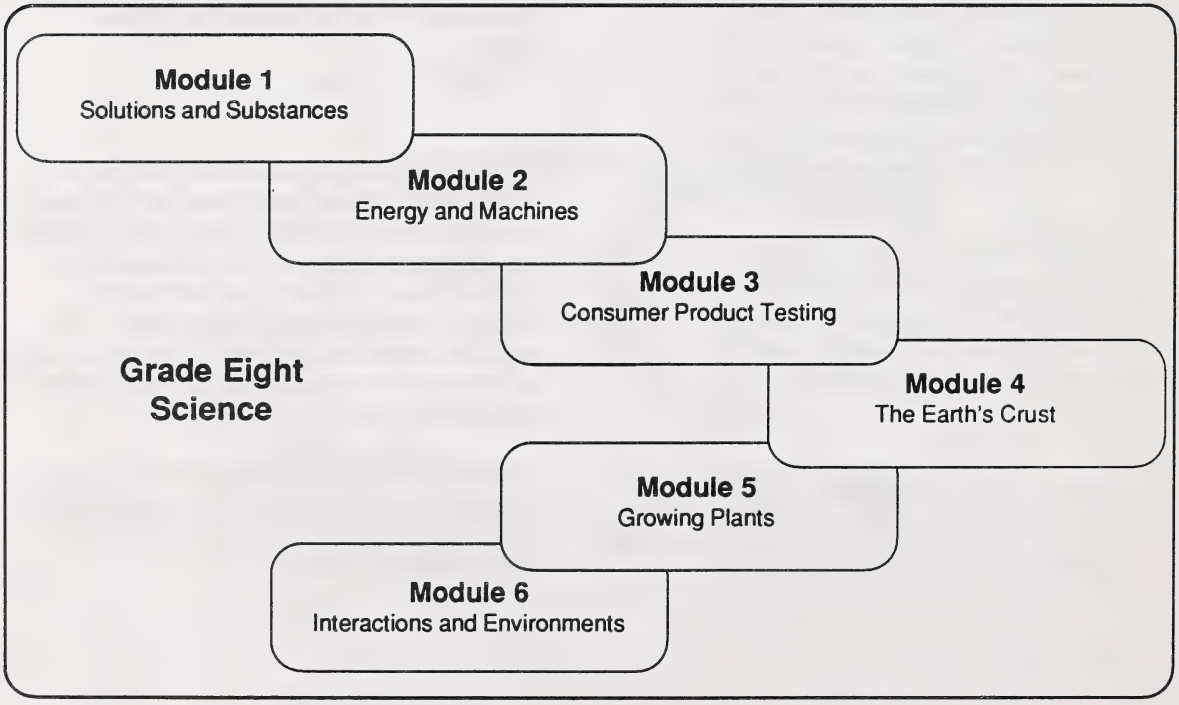
A DESCRIPTION OF SCIENCE 8

Aims of the Grade 8 Science

The Grade 8 Science course aims to develop the following:

1. a basic foundation of scientific knowledge
2. an understanding of how scientific knowledge is gathered
3. an understanding of how scientific knowledge is used to solve practical problems
4. an awareness of how science and technology effect the individual and society
5. an ongoing interest in science

Course Structure



The Grade 8 Science course consists of six modules which should be done in numerical order. However, Module 6, which requires outdoor activities during the growing season, can be rescheduled for an appropriate time of the year.

The context is presented with three contents:

(1) **Nature of Science** (S) – the process by which scientific knowledge is gathered

(2) **Science and Technology** (ST) – the application of science to the solution of practical problems

(3) **Science Technology and Society (STS)** – the effect of science and technology on society

Each module has a particular science topic and emphasizes one of the contexts above. This is shown in the table.

Module	Emphasis	Content
1. Solutions and Substances	S	• deals with chemical solutions and their properties • also covers solubility and separation of materials into component substances
2. Energy and Machines	ST	• deals with mechanical systems, subsystems, efficiency, effectiveness, energy, energy conversions, and energy conservation
3. Consumer Product Testing	STS	• deals with product testing, safety, reliability, effectiveness of products, and the need for quality information in product selection
4. The Earth's Crust	S	• deals with formation of rocks, volcanic action, earthquakes, crustal movements, and fossils
5. Growing Plants	ST	• deals with plant structure and functions, growth, and propagation
6. Interactions and Environments	S	• deals with food and energy transfer, roles of organisms in their enviroment, and effects of human intervention on the environment

Symbols and Terms Used in This Course

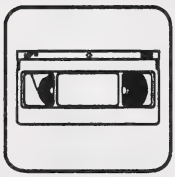
Symbols

Science 8 has a number of symbols in the margins. These symbols are used throughout the course.

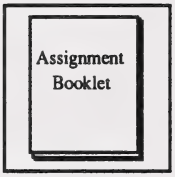
Videocassette

Textbook

Course audiocassette providing general teacher guidance



Read



Assignment Booklet

Be sure that you and the students become familiar with these symbols.

Terms

When new terms or concepts are introduced in the course, it is important that the students understand that the terms are new and that they should read carefully to fully understand what the terms mean. The course has been designed so that new terms or concepts are given special attention. They are **defined** and **explained** within the sentence or paragraph. Their meaning is provided at the bottom of the page or in a note in the margin. Also check the beginning of the appendix in each module booklet. Sometimes a special glossary is included. As you supervise, make sure the students know what the new term and concepts are and what they mean.

COURSE MATERIALS

Materials

Materials Supplied	Materials Required	Optional Materials
Courseware Student Support Guide (6) Module Booklets (6) Assignment Booklets (6)	**Textbook** *Science Directions 8*	
Media Special audiocassettes providing general teacher guidance.	**Media** **Other** For a list of additional materials see the module introductions that follow.	**Media** VCR (VHS) audiocassette player **Other** Videocassettes used in the course may be available from the Alberta Distance Learning Centre or call your local school authorities.

When you receive your course materials, you should take time to look carefully at what you received. **Take note that your entire course may not be sent at one time.** If you received the wrong course or your course is defective in any way, notify the Student Services Department of the Alberta Distance Learning Centre immediately.

Handling the Courseware

Courses may involve audiocassettes and/or videocassettes. Whether the material is loaned or purchased, it is important to take care of these items. Scratches, dirt, grease, extreme temperatures, or magnetic fields such as those in electric motors will damage them.

EVALUATION

There are two kinds of evaluation used in the course: informal and formal. As the learning facilitator you will take part in the informal evaluation.

Informal Evaluation

The course contains two types of activities. In the module booklets there are learning activities that include basic practice and questions that help guide the students to a better understanding. It is important that these activities are corrected as soon as possible so the students get immediate feedback to confirm and clarify their understanding before they go on.

In a classroom these types of activities would be corrected as they are completed by the teacher or by the students. In distance learning courses at the high-school level, the answers for these activities are included in the appendix of each module booklet so that the students can mark the activities themselves. **At the elementary and junior-high level, correcting the activities and discussing the results is one of the most important duties of the learning facilitator.**

When the student has completed an activity, you should skim over it before correcting to be sure the student has spent enough time and effort on the activity.

When checking a student's work, first focus on the work the student has done correctly and then comment on the student's effort. Then, if necessary, spend time clearing up any misunderstandings.

Following are a few suggestions that have proved to be constructive ways of handling errors. First, stop to consider why there are errors. Ask yourself the following questions:

- Is the student repeatedly making the same mistakes or do the errors appear to be random?
- Do the errors appear to be the result of carelessness?

If the student is repeatedly making the same mistakes, you may need to read through that section and explain in your words what the main ideas are.

If the error is random and doesn't have a serious impact, then it is worth ignoring.

If the error appears to be careless, you may need to

- check to see if the student understands the directions
- relate the activity where the errors occur to some meaningful aspect of the student's life
- discuss the information with the student
- have the student slow down
- give the student a rest

Always instruct the student to correct incorrect answers. The module booklet becomes an important reference when doing the assignments, and it is essential that it is accurate.

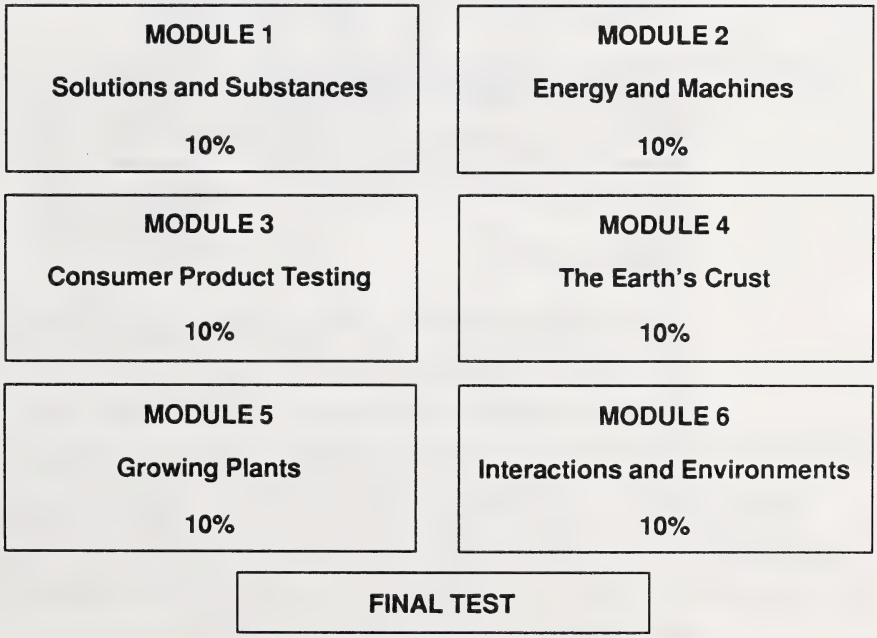
Remember, it is very important that students not only learn from their corrections, but that they also realize that making mistakes is a normal part of learning.

You may decide to let the student correct some of the activities after you have ensured that the student has spent enough time and effort on the activity. Make sure that you see the activity with its corrections before letting the student go any further in the module booklet.

It is of little value to students if you do their work. How many items are incorrect is not the most important thing, but how the mistakes are handled. Sometimes it is easier when you're guiding the student to put in the answers, but it does not help the student learn the concept. Activities with examples have been included with the student modules to provide guidance for the students.

Formal Evaluation

Formal evaluation is based on the assignments in the assignment booklets which are marked by a distance learning teacher. There is an assignment booklet for each module in the course. The assignments are based on the work the student has completed in the module. The student may refer to the module booklet while completing the assignments. The following chart shows the percentage of the final course mark assigned to each module. The final mark is determined by how well the student does on all the modules.



Module Evaluation

Each module submitted to the distance learning teacher is evaluated on the basis of the student's demonstrated understanding of the concepts taught in that module, completeness of work, neatness, and legibility. A letter grading is then assigned which follows the scale of percentage or performance equivalencies below.

A	80% – 100%	Outstanding
B	65% – 79%	Good
C	50% – 64%	Satisfactory
D	40% – 49%	Needs Improvement
F	0% – 39%	Unsatisfactory
I	Incomplete	Follow distance learning teacher's directions and return entire module in order to receive a grading.
R	Repeat	

Final Mark

Science, being a core subject in Junior High, requires the writing of a final examination which must be supervised by a responsible adult. (See the *Handbook for Junior High Students* for details.) This supervised test must be written before the student's registration expires. The test will not be returned to the student. In order to receive a passing grade in Science 8, the student must score a "D" or better on the final exam and have an overall standing of "C" or better for the entire course.

The final mark is determined by how well the student does on all the modules and the final test. The test will make up 40% of the student's mark. The other 60% will be based on course work, as evaluated by the student's distance learning teacher. If a student is dissatisfied with a mark, an appeal test may be requested. Such a request must be made by the student within thirty days of receipt of the result statement.

Report Cards

Report cards are mailed twice a year – in October and in February – to all nonschool students under sixteen years of age. The principal or superintendent is also sent a copy of the report card. This card shows the number of modules completed in the course, the average grading per module, and the final mark received for the completed course.

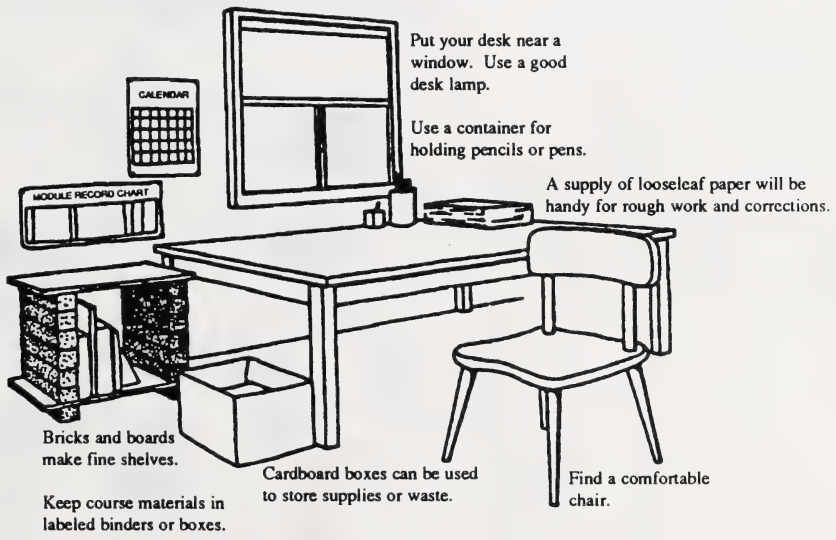
STARTING OUT RIGHT

Proper planning, organization, and good study habits will help your student to succeed in acedemic studies. This section of the guide will give you and your student some idea of how to use time efficiently so that the student can achieve predetermined goals. If you are new to distance learning, both you and the student will probably benefit from the tips on time management and study habits in this section.

Setting Up Shop

Probably one of the best ways to ensure success in distance learning is to establish a study corner. This is a quiet, well-lit area where the student can leave books, papers and supplies. It should be an area where there are no distractions – telephone, radio, television, or people engaged in other activities. Find the best place for studying in your home. A comfortable chair and sufficient work space (table or desk) are essential. All necessary supplies, tools, materials, and books must be gathered. The work area could contain exercise equipment like barbells or even an exercise bike. When your student begins to feel sluggish, encourage a ten minute exercise break.

The following diagram may be helpful for organizing your study area.


Put your desk near a window. Use a good desk lamp.
Use a container for holding pencils or pens.
A supply of looseleaf paper will be handy for rough work and corrections.
CALENDAR
MODULE RECORD CHART
Bricks and boards make fine shelves.
Keep course materials in labeled binders or boxes.
Cardboard boxes can be used to store supplies or waste.
Find a comfortable chair.

Students should keep these things in their work area:

pens	atlas	extra paper	writing portfolio	return envelopes
pencils	eraser	thesaurus	library books	module materials
glue	dictionary	timetable	pencil crayons	ADLC phone number

An efficient student work place will help learning.

Time Management

There are so many demands on our time nowadays that we really must make the effort to organize our work and our activities. This organization or planning is called time management.

With distance learning, it is a necessity that the student plans a schedule. Your duty is to ensure that the student does some advance planning. Check the final plans to see if they are realistic.

Only you and the student knows exactly how much time is available for completing a course. It does not matter too much what time of day the student does course work – this varies with the individual's situation. Distance education is flexible. To decide exactly how much time the student must make for studies, the student must set priorities. Together you must decide exactly when you wish to have the course completed. You must take into account time worked away from home, time needed for chores, and time needed for recreation and relaxation when you make this estimate.

Make a Weekly Plan

Discuss with your student the importance of weekly planning.

People who write for a living always have deadlines to meet. They cannot wait for inspiration. They discipline themselves to sit down and write for a number of hours every day. Whether they like it or not, they stick to a schedule. This determines success.

Work with your student to

- keep track of what your student usually does in a typical week
- plan the studies your student can do in a typical week
- keep a list of what your student must do each day and cross off each study task as it is completed
- find your student's own best time to study
- set deadlines and stick to them
- not dwell on failures and get back on schedule

Have the student fill in a weekly timetable.

Sample Weekly Timetable

Begin when the student usually wakes up.

Write in every hour.

End when the student usually goes to bed.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

The student should keep track of every major activity. It is not wise to plan to use 100% of the student's time. Allow for possible interruptions and jobs taking longer than planned.

Make a Monthly Plan

The next step is planning a monthly schedule with your student. The student should block off the days that are not available for studying.

- Count the days that are available between the start of the course and the desired finishing date.
- Allow time for review.
- Count the number of sections or modules that must be completed within this time.
- Estimate how many days are available to complete each section and each module.
- Make a monthly plan like the one below.

Sample Monthly Timetable

September

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	~~2~~
~~3~~	~~4~~	5	6	7	8	9
10	11	12	~~13~~	14	15	~~16~~
17	18	19	20	21	22	23
~~24~~	25	26	27	~~28~~	~~29~~	30
Total Work Days Available for Study						
Goal :						

Make a Course Plan

When you both have an idea of how much time is available every day, week, and month, look at a plan for completing the course(s) that the student is studying.

Modify these plans as circumstances change. Be flexible, but don't procrastinate.

Our experience has shown that a planned approach to module completion is far better than the hit-and-miss method of completing modules now and then, as you feel like it.

Sample Course Timetable

Course Name _____ Date of Starting _____

Planned Completion Date _____ Actual Completion Date _____

Module	Planned Completion Date	Actual Completion Date	Date Mailed	Date Returned

The student needs determination and perseverance to continue working independently. The student also needs your positive support and interest to keep motivated.

Supervising the Completion of Modules

Try to ensure that the student is following the timetable established as closely as possible and that the target dates for module completions are being met. If, for some reason, the student misses time from studying, the student should spend additional time during the evenings or weekends, so as to complete the course(s) within the desired time limits.

When the student has completed the learning activities, you should allow the student to do the assignment in the assignment booklet. Afterwards you should go over the assignment to ensure the student has spent enough time on the assignment. When the entire assignment booklet is done satisfactorily, submit the assignment.

Basic Study Tips

Planning and good study habits will help the student to succeed in distance learning. Here is a short list of important tips to discuss with the student.

- Work together to make a course plan and weekly timetable, and follow them as closely as you can.
- Remember that mornings are usually better for concentration. Learning styles may vary from student to student.
- Check to see that all necessary materials and supplies are close by before starting work.
- Have the student take relaxation or exercise breaks between study periods.
- Be sure that the student completes all activities carefully and reviews corrections before moving to other assignments.
- Ensure that the student understands and follows directions carefully when completing activities. If the student is unclear about what to do, the student should then start by rereading the directions. If there are still problems, the student should discuss the activity with the learning facilitator. Sometimes reviewing the previous activities is helpful.
- Ensure that written responses are the student's own work.
- Encourge the student to switch subjects or activities before they become stale. If the student is working regularly and truly concentrating, one or two hours on one subject should be enough at one sitting.
- Have the student be sure that writing is neat, legible, and complete.
- Encourage students to discuss their reading and writing with you.

PROCEDURES

How to Send in Your Assignment Booklets

Assignment booklets, along with any other requested materials, should be submitted to the Alberta Distance Learning Centre as soon as possible after the completion of each module in order to obtain speedy, regular evaluation and feedback. The student can proceed with the next module while waiting for the return of the assignment booklet.

Please ensure that your student's file number is on all assignments, tapes, and disks sent to the Alberta Distance Learning Centre.

Report any change of address immediately. If a change is not reported, it is impossible for the school to forward information, letters, or test applications.

Mailing

The student is required to pay the postage on everything sent or returned to the Alberta Distance Learning Centre. To speed up handling, first-class postage is recommended on all assignments submitted.

The student is expected to perform assigned work and to correspond with teachers and administrative staff in an appropriate manner. The Alberta Distance Learning Centre reserves the right to cancel, without refund, the course of any student whose conduct is unbecoming.

Do not enclose letters concerning fees, guidance, additional courses, final tests, or general inquiries with assignments. Send these by separate mail to speed their handling and to avoid their being misplaced.

Dropping Off Your Assignment Booklets

You may drop off assignments at the Edmonton Study Centre or in Barrhead at the Alberta Distance Learning Centre.

Faxing Your Assignments

Be sure the covers of your assignment booklets are filled in correctly with the proper label attached.

Check to see that all response pages have been completed as directed.

Check to see that all faxing boxes located at the bottom of each response page have been clearly filled out.

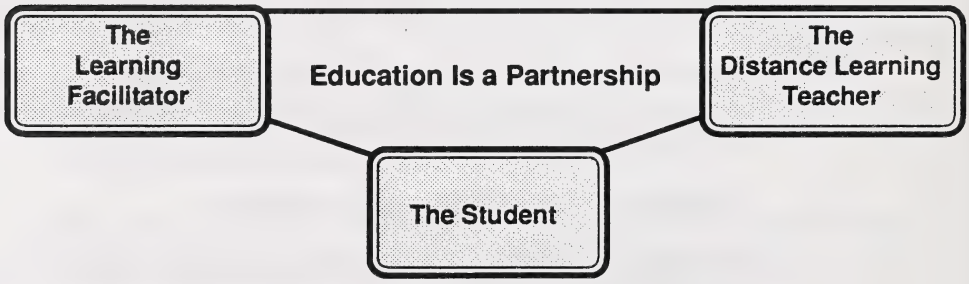
Costs for faxing assignments to the Alberta Distance Learning Centre are the responsibility of the student.

What to Do with Returned Assignment Booklets

Review returned assignments carefully with the student, noting the marks, teacher's corrections, and comments. The teacher may suggest that you make certain choices of activities in future modules to help you practise needed skills. Your teacher may also ask you to complete skill activities which are either included in the course or sent to you by the teacher. Returned assignments should be kept for future review and study.

SUMMARY

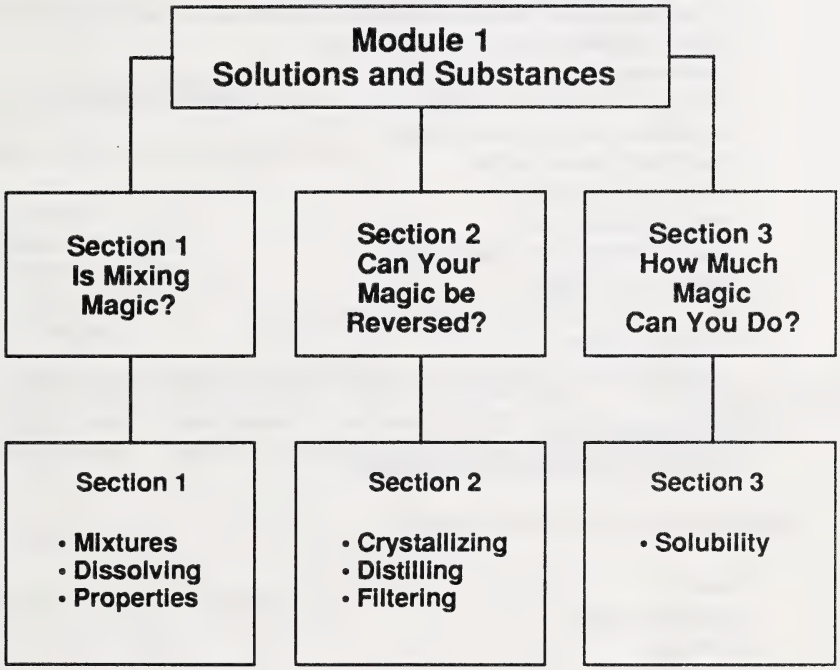
This introductory section of the Student Support Guide has been developed to assist you in your role as learning facilitator. Develop a routine with your student and a good working relationship. Remember, education is a partnership.



Module 1 – Solutions and Substances: Overview

The major emphasis of this module is the nature of science.

This module is an introduction to the study of solution chemistry. Students learn basic principles of solubility by investigating different kinds of solutions and their properties. The knowledge of solubility is applied to the separation of materials into component substances.



Materials and Equipment

The equipment listed is for an individual or a group. Adjust the amount of equipment if more than an individual or group is involved.

The following equipment will be needed:

- seven test tubes with matching stoppers or medicine vials
- one test tube with matching stopper, or jar with a lid
- 10 mL graduated cylinder or a tablespoon to measure equal volumes of liquids
- spoon to measure equal volumes of solids
- thermometer is suggested but not required
- three 250 mL beakers or identical glasses which can withstand hot water
- two 400 mL beakers, jars, or bowls
- one 600 mL beaker or jar
- one 1000 mL beaker or jar
- one petri dish or bowl
- funnel or top half of a plastic jug
- stirring rod or spoon
- filter paper or coffee filter without central hole
- hot plate or stove
- milk carton, can, or pot lid larger than mouth of container being heated
- tongs
- stopwatch or clock
- hand lens is suggested but not required

The following materials will be needed:

- water
- granulated sugar
- vinegar
- sugar cubes
- cooking oil
- baking soda
- salt
- sand
- pepper
- ice
- food colouring
- solutes that change water's colour when dissolved (e.g. instant coffee)
- lemon juice

Evaluation

Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete three section assignments. The assignment breakdown is as follows:

Section 1 Assignment	**40%**
Section 2 Assignment	**30%**
Section 3 Assignment	**30%**
TOTAL	**100%**

Section 1: Is Mixing Magic?

Key concepts in this section are the following:

- pure substance
- homogeneous mixture
- heterogeneous mixture
- dissolving factors
- solution properties

This section introduces students to solution chemistry and the inquiry process. Students are first introduced to the classification of matter. They learn the differences between homogeneous and heterogeneous mixtures. Dissolving factors and solution properties are also examined.

Section 1: Activity 1

The following are needed for this activity:

- water
- vinegar
- cooking oil
- salt
- pepper
- sugar
- baking soda
- seven test tubes with matching stoppers, or medicine vials
- 10 mL graduated cylinder, or a tablespoon to measure equal volumes of liquids
- spoon to measure equal volumes of solids

1. Look back at the list you brainstormed. Using that list, answer the following questions.

   a. How many products are solids?

   b. How many are liquids?

   c. How many are gases?

   d. How many of your substances do you consider dangerous?

   The answers will vary.

   Some common household products are the following:

   - *ammonia (liquid)*
   - *pepper (solid)*
   - *milk (liquid)*
   - *sugar (solid)*
   - *vinegar (liquid)*
   - *detergent (solid or liquid)*
   - *salt (solid)*
   - *natural gas (gas and dangerous)*

2. Explain the differences between a mixture and a pure substance.

   A mixture is made of more than one kind of matter.
   A pure substance has only one kind of matter.

3. List five main safety tips you should always follow in a science laboratory.

   Answers will vary. Some possible answers are given.

   - *Tie back loose hair.*
   - *Wear safety glasses when working with dangerous chemicals.*
   - *Do not wear baggy clothing to do experiments.*
   - *Be careful. Carelessness can cause accidents.*
   - *Assume substances are harmful unless your teacher tells you otherwise.*

Comment:

For the upcoming lab assignment encourage students to wear safety glasses, dust mask, rubber gloves, and a protective apron. While this is not necessary for these chemicals, students do need to be aware of what safety precautions can be taken when dealing with unknown materials. If the equipment is not available, at least discuss safety precautions.

4. What is the problem given in Activity 1-2?

   How can mixtures be classified?

5. How do you think mixtures are classified?

   Answers will vary. Since predictions are guesses, no student that addresses the question can have a wrong answer. A sample response is given. Mixtures can be classified as solids, liquids, or gases.

6. Complete the chart as you make your mixtures.

   Students may make some unusual observations. They may find an insect, for example. This exercise is to introduce dissolving. That is all that is to be recorded here. Inspect student charts to see if their observations are reasonable.

Mixture	Observations
water and vinegar	• *dissolving occurs* • *forms a clear liquid*
water and cooking oil	• *dissolving doesn't occur*
salt and pepper	• *dissolving doesn't occur*
sugar and baking soda	• *dissolving doesn't occur*
water and baking soda	• *baking soda dissolves* • *forms a clear liquid*
cooking oil and baking soda	• *dissolving doesn't occur*
salt and water	• *dissolving occurs* • *forms a clear liquid*
water and sugar	• *dissolving occurs* • *forms a clear liquid*
sugar and cooking oil	• *dissolving doesn't occur* • *The sugar settles.*

7. a. Name a solid substance that seemed to disappear when mixed with another substance.

   Three possible answers are baking soda, salt, and sugar.

   b. What was it mixed with?

   They were all mixed with water.

8. a. Name a liquid substance that seemed to disappear when mixed with another substance.

   A liquid substance that seemed to disappear when mixed with another substance was water.

   b. What was it mixed with?

   It was mixed with vinegar.

9. Name two mixtures where both parts were visible after mixing.

   There are four possible answers. They are as follows:

   - *water/cooking oil*
   - *salt/pepper*
   - *baking soda/cooking oil*
   - *sugar/cooking oil*

10. *Your mixtures were neither pure substances nor natural substances.* Explain why this statement is true.

    Answers will vary, but the key concept is the same as presented by the following:

    - *Mixtures cannot be pure substances.*
    - *Natural mixtures cannot be manufactured by humans.*

Section 1: Activity 2

The following are needed for this activity:

- sugar cubes
- water
- stopwatch or clock
- beaker or glass

1. What is a homogeneous mixture? Include the words *homogeneous*, *dissolve*, *solvent*, and *solution* in your answer.

   The answers should be a short paragraph. Students with weaker writing abilities should be given support. Assignment 1 will be marked for writing skills. This paragraph should include these points:

   - *Homogeneous mixtures are formed when a solute dissolves in a solvent.*
   - *Homogeneous mixtures are also called solutions.*

2. What is the difference between a solute and a solvent?

   Students should complete this question in full sentences. These concepts are to be addressed:

   - *The solute is the matter that is dissolved.*
   - *The solvent is the matter that does the dissolving.*

3. How do you know when a liquid solution has formed?

   Although a liquid solution may be coloured, it is always clear.

4. What are the three ways a liquid solution can form?

   All three ways of forming a liquid solution use a liquid solvent. The solute added to the solvent may be a solid, a liquid, or a gas.

5. What is the difference between an aqueous solution and a nonaqueous solution?

   The solvent is always water in an aqueous solution. In a nonaqueous solution the solvent is never water.

6. Give an example of an aqueous solution and a nonaqueous solution.

   Examples of an aqueous solution are tea and ocean water. Air and brass are examples of nonaqueous solutions.

7. Explain the difference between homogeneous and heterogeneous mixtures. Include the alternate name for each.

   Heterogeneous mixtures, also called mechanical mixtures, are formed when dissolving does not occur during mixing. Homogeneous mixtures, or solutions, are formed when dissolving does take place during mixing.

8. Classify some of the solutions you have just found as either natural or human-made. Complete the chart so that you have six examples of each kind of solution.

Answers can vary. A sample response follows.

Natural Solutions	Human-made Solutions
tears	clear apple juice
clear air	*water and methanol*
sweat	*vinegar*
saliva	*tea*
urine	*bronze*
untreated water	*clear shampoo*

9. Use your observations from Step Five in Activity 1. Decide if the solute was soluble or insoluble. Classify each mixture as being either homogeneous (a solution) or heterogeneous. You may leave the boxes blank for the two mixtures not completed in Activity 1.

Mixture	Soluble or Insoluble	Homogeneous or Heterogeneous Mixture
water and vinegar	*soluble*	*homogeneous*
water and cooking oil	*insoluble*	*heterogeneous*
salt and pepper	*insoluble*	*heterogeneous*
sugar and baking soda	*insoluble*	*heterogeneous*
water and baking soda	*soluble*	*homogeneous*
cooking oil and baking soda	*insoluble*	*heterogeneous*
salt and water	*soluble*	*homogeneous*
water and sugar	*soluble*	*homogeneous*
sugar and cooking oil	*insoluble*	*homogeneous*

10. Which mixtures were aqueous solutions?

The following are aqueous solutions:

- *water and vinegar*
- *water and baking soda*
- *water and salt*
- *water and sugar*

11. None of the mixtures were nonaqueous solutions.

Give an example of a nonaqueous solution.
Answers can vary. Some nonaqueous solutions are air, brass, bronze, and crude oil.

12. For each of the homogeneous mixtures identified, name the solute and solvent. Put a cross in the Solute and Solvent boxes if the mixture is a heterogeneous mixture. Leave the boxes blank for the two mixtures you did not make.

Mixture	Solute	Solvent
water and vinegar	*vinegar*	*water*
water and cooking oil	*X*	*X*
salt and pepper	*X*	*X*
sugar and baking soda	*X*	*X*
water and baking soda	*baking soda*	*water*
cooking oil and baking soda	*X*	*X*
salt and water	*salt*	*water*
water and sugar	*sugar*	*water*
sugar and cooking oil	*X*	*X*

Section 1: Activity 3

The following are needed for this activity:

- sugar cubes
- hot and cold water
- thermometer if available
- two identical glasses or beakers

1. Think about the situation. There are three possible problems that could be investigated by experiment. Each of these relates to dissolving. One of these is given to you. What are the other two?

   a. What effect does temperature have on the dissolving rate of sugar?

   b. *What effect does the particle size have on the dissolving rate of sugar?*

   c. *What effect does the mechanical movement of the water have on the dissolving rate of sugar?*

2. Write your hypotheses for the three possible investigations.

   a. *As temperature increases, the dissolving rate of sugar increases.*

   b. *As particle size increases, the dissolving rate of sugar decreases.*

   c. *As mechanical movement increases, the dissolving rate of sugar increases.*

   A hypothesis calls for a validated prediction. The students must be able to explain why they think their hypothesis is correct. The student hypothesis should reflect knowledge learned thus far in this section. If a student can back up a prediction with facts, then the hypothesis is correct.

3. Write the procedure you are going to follow to test your hypothesis.

   By Grade 8 most students have been introduced to manipulated, responding, and controlled variables. These concepts will be addressed in Section 3 of this module. The problem shows that the manipulated variable is the temperature of water. The dissolving time of the sugar cube is the responding variable. Two controlled variables are the amount of mechanical movement and particle size. Both factors are kept constant. Other controlled variables are indicated in the sample procedure. Students do not have to acknowledge these variables formally, but their procedure should reflect an understanding of variables. If the student response to this question indicates a lack of understanding of the science inquiry process, give support at this point. A sample procedure is given.

   - *Fill one glass with hot water.*
   - *Fill an identical glass (controlled variable) with cold water.*

- *Take two sugar cubes from the same box (controlled variable) and drop one in each glass at the same time (controlled variable).*

- *Watch to see whether the hot water or cold water dissolves the cube faster. Record your results.*

An alternative approach would be to make two trials. One trial would be to use hot water, the other cold water. Using this approach, the dissolving times for both trials would be timed and recorded.

4. Draw the chart you designed. As you follow your procedure, enter your results in the chart.

   Charts will vary, but they must include dissolving rate (time) and temperature of water. If students used a method similar to the example given, they will use relative time (faster/slower).

5. What effect does temperature have on the dissolving rate of sugar?

   As water temperature increases the dissolving rate of sugar in that water increases.

6. Was your hypothesis correct? Explain.

   If experimental evidence does not support an original hypothesis, a scientist has learned something. Give support to students who cannot explain why their hypothesis was wrong.

7. There are three dissolving-rate factors. State what these three factors are. Explain how each factor influences the dissolving rate of a solute.

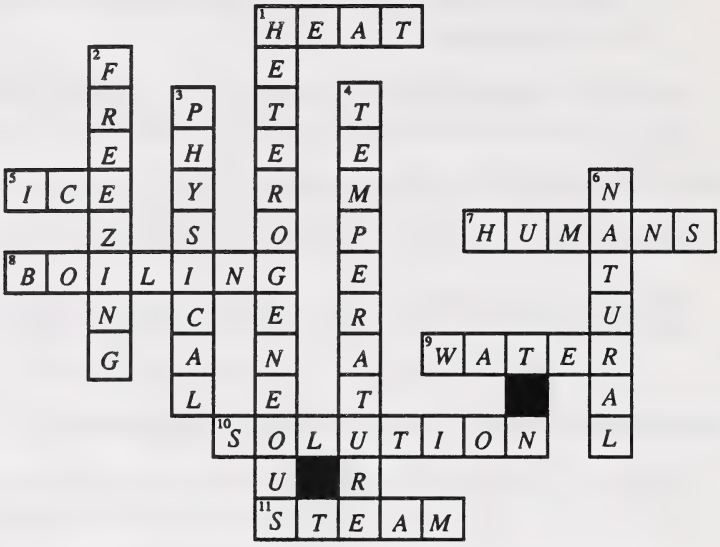
   The three factors that affect dissolving rate are temperature, particle size, and mechanical movement.

   - *As the temperature of the solute increases, the dissolving rate decreases.*

   - *As the particle size of a solute increases, the dissolving rate decreases.*

   - *As the mechanical movement increases, the dissolving rate of the solid (sugar) also increases.*

8. The puzzle will give you an opportunity to review many of the new terms you have learned in this module. Complete the puzzle.



9. People drink a variety of liquid solutions. Over the next two days keep a list of the liquid solutions you see people drinking. Fifteen or twenty minutes will be all it will take to do this exercise. There is no need to search very hard. Liquid solutions are very common. Along with your list, keep track of the colours and any other unusual characteristics that the liquid solutions have.

Answers can vary. One response is shown in table form.

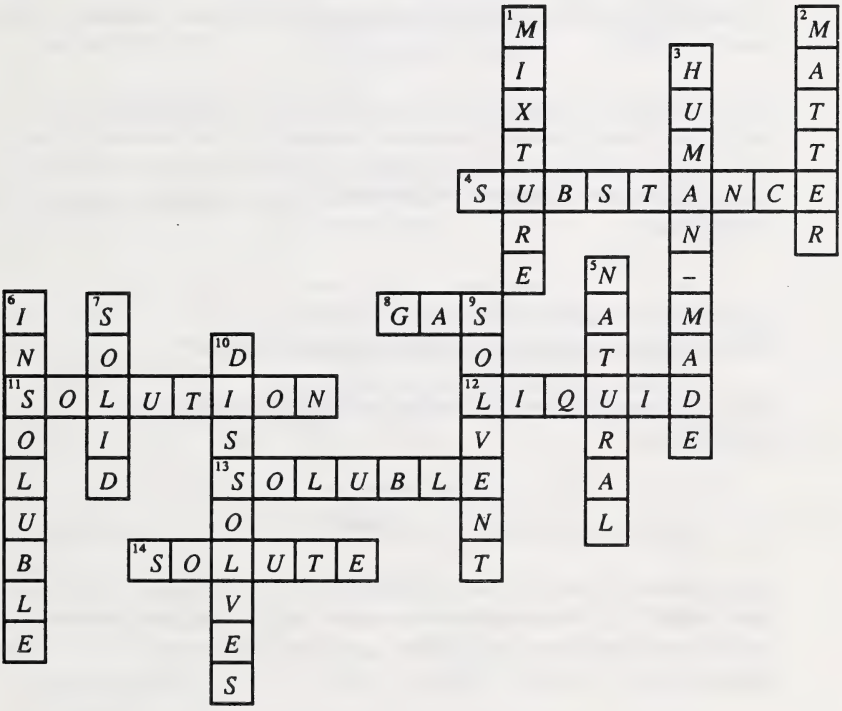
Beverage	Colour	Other
coffee	dark brown	–
tea	brown	–
lemonade	light yellow	–
pop	colourless	bubbly

Section 1: Activity 4

The following are needed for this activity:

- water
- three 250 mL beakers or glasses
- stirring rod or spoon
- solutes that change water's colour when dissolved

1. Complete the following puzzle.



2. All types of matter can be solid, liquid, or gas. Water has three different names depending on whether it is a solid, liquid, or gas. Write these names and indicate whether the name refers to solid, liquid, or gaseous water.

   The names and states of each are as follows:

   - *ice – solid water*
   - *water – liquid water*
   - *steam or water vapour – gaseous water*

3. An increase in temperature can change solids to liquids. What other changes can a change in temperature make? Before you answer this question, ask yourself, "Does temperature only increase?"

   - *A temperature increase can change liquids to gases.*
   - *A temperature decrease can change gases to liquids.*
   - *A temperature decrease can change liquids to solids.*

4. Write a paragraph based on your observations. For each solute used, describe the physical appearance of the solution containing that solute. If you are working at home, consider making solutions that are safe to drink. If you do so, you will have something to enjoy while you write your paragraph.

   The answers to this question will be varied. Colour is the physical property of solutions being studied, and student paragraphs should reflect this. Food colouring, clear juices, coloured crystals, or coloured powders are examples of substances that can change the colour of water. Assignment 1 gives marks for writing skills. Give students with weaker writing abilities support at this point.

5. At sea level the boiling point of water is 100°C.
   What can happen to that boiling point if a solute is added?

   When the solute is added, the boiling point may increase, decrease, or remain constant depending on the solute.

6. Why is salt used on roads in the winter time?

   Salting roads is done to prevent accidents due to icy conditions. Salt lowers the freezing point of water up to 15°C. When added to wet roads, salt prevents the formation of ice when the temperature drops below 0°C. When salt is added to icy roads, the salt causes the ice to melt if the temperature is above –15°C.

Section 1: Follow-up Activities

Extra Help

1. Complete the following table.

Answers will vary. One response is shown.

Term	Meaning and Example
soluble solution	• *dissolves in a solvent* • *salt dissolves in water*
aqueous solution	• *a solution that uses water as a solvent* • *sugar water*
insoluble solute	• *does not dissolve in a solvent* • *sugar does not dissolve in cooking oil*
nonaqueous solution	• *a solution that does not use water as the solvent* • *air, brass*
heterogeneous mixture	• *a mixture in which the parts are distinguishable* • *sand and iron filings*
natural nonaqueous solution	• *a solution not made by humans that does not use water as the solvent* • *clean air*
human-made aqueous solution	• *a solution made by people that uses water as the solvent* • *tea, sugar water, salt water*

Enrichment

1. Imagine that it is spring time. You live on a farm in northern Alberta. Most of your community's business depends on tourism. You have a huge pond on your property. Experts have told you that your livestock will never be able to drink from the pond. Financially, you are almost broke. If you do not make money soon, you are going to lose your farm. From what you have learned about solutions and their physical properties, create a use for the pond that will attract tourists.

   The answers to this question will be varied. Physical properties of solutions were mentioned in the question, therefore these properties should be incorporated into the answer. A few samples of possible student responses follow.

   - *Colour is the physical property of solutions that could be used to attract tourists to the pond.*
   - *Depending on the solute added, the pond could be made any colour.*
   - *The colour of the pond could be changed to attract new and repeat business.*
   - *Winter ice skating on coloured ice would be intriguing to winter sport enthusiasts.*
   - *Adding the right solute could lower the freezing point of the water. Tourists would find it intriguing to go boating in a coloured pond when the other water surfaces were frozen.*

   Assignment 1 gives marks for writing skills. Give students with weaker writing abilities support at this point.

2. Your project might affect others. What environmental considerations should you make before proceeding?

   The answers to this question will be varied. Students of this age are generally concerned about pollution. Sample responses follow.

   - *The solutes added could kill plants and animals in the pond.*
   - *The solutes could be toxic. People might get sick or even die from drinking the water.*

Section 2: Can Your Magic Be Reversed?

Key concepts in this section are the following:

- settling
- filtration
- evaporation
- crystallization
- distillation

This section introduces students to the practical science of separating mixtures. It has two parts. In the first part of the section, students have the opportunity to separate heterogeneous mixtures using the techniques of settling and filtration. In the second part of the section, distillation and evaporation are used by the student to separate homogeneous mixtures.

Section 2: Activity 1

The following are needed for this activity:

- 600 mL beaker or jar
- four teaspoons of sand
- water
- spoon or stirring rod
- test tube and stopper, or jar with lid
- petri dish or bowl
- funnel or top half of a plastic jug
- filter paper or large coffee filter
- two beakers, jars, or bowls
- food colouring

1. What separation procedure is shown?

   Settling is the separation procedure shown.

2. Explain how to separate using this method.

   When particles are too heavy to be suspended by a liquid they fall to the base of the container. When these heavy particles have accumulated at the bottom of the container, the liquid can be poured out. The heavy particles have been separated from the mixture by a process called settling.

3. What separation procedure is shown?

   Filtration is the separation procedure shown.

4. Explain how to separate using this method.

   To separate a mixture by filtration you need a funnel and some type of filter. Paper filters are commonly used, but pebbles and sand can also be used to make an effective filter. The filter is placed inside the funnel. The mixture is poured into the paper filter. The filtrate is collected in a container. The residue is collected from the filter paper.

5. Great plans seldom come without thinking. Use one of the two filtering methods you have already learned, or design your own. Explain your plan. You may draw a model if that will make it easier.

   Answers will vary. A sample plan is given.

   - *Put two teaspoons of sand into 200 mL of water.*
   - *Stir the mixture.*
   - *Insert a filter into the funnel.*
   - *Pour the mixture slowly into the filtration apparatus.*
   - *Collect the filtrate and the residue.*

6. Did your design work better than the settling process? Explain.

   Very fine dirt particles do not settle. Students should find that their filtration sample is clearer than the one collected by settling.

7. Why does the dye go through your filter with the water?

   The dye particles must be smaller than the holes in the filter.

   Some students may ask questions about the size of particles. The program of studies does not include the particle theory of matter. To answer questions concerning particle size you may want to address the particle theory briefly. The text, ***Science Directions 8****, explains this theory on pages 4 and 5.*

Section 2: Activity 2

The following are needed for this activity:

- water
- hot plate or stove
- beaker or pot
- milk carton, can, or pot lid larger than mouth of container being heated
- ice
- food colouring
- salt
- tongs

Comments:

It is recommended that distillation of a coloured solution be demonstrated as in the text, **Science Directions 8,** Activity 1-10 on page 29. Note that the materials for this demonstration are not included in the preceding list. Finding Out, questions 1-5, may be discussed with your students. Responses to these questions follow.

Textbook question 1. *Answers vary according to the starting solution.*

Textbook question 2. *The residue colour will intensify and it may appear to be thicker due to the loss of water.*

Textbook question 3. *The distillate should be colourless and look like water.*

Textbook question 4. a. *The distillate seems to be water removed from the solution.*

b. *The solute remains in the flask and the solvent has been caught in the test tube. Therefore, both have been recovered.*

Textbook question 5 a. *The distillate was a gas.*

b. *Two changes of state occurred.*

c. *Vapourization occurred in the flask. Condensation took place in the test tube.*

Students should be closely supervised for Activity 2. Hot materials are involved.

1. Explain how distillation works.

   The distillation process has two parts. First the liquid mixture is heated to increase the evaporation of one of the mixture's components. Then this evaporated component is condensed and collected.

2. Think over your alternatives. Draw a picture of the design you decide to use for distillation.

   Answers can vary. This exercise was designed to allow alternatives for the students. The simplest method is to use a saucepan and lid. When the pan containing the aqueous solution is heated, the evaporated water condenses on the lid. The lid can be tipped to collect the distillate in a separate container. Several other alternatives were given in the Study Guide. Creative students may invent their own procedure. Student safety is the only constraint for this exercise.

3. Describe the steps you plan to follow.

   Answers can vary. A sample plan follows.

   - *Place 200 mL of solution in the pan.*
   - *Turn the heat on high.*
   - *When the solution starts to steam (nears the boiling point), place the lid (or container filled with ice) over the pan. Use tongs to hold the lid.*
   - *Occasionally tip the lid so that the condensed distillate can be collected in a separate container. If containers filled with ice are used, they are placed over another container. The condensed distillate will drip into the container underneath.*

   An oversized lid will collect more distillate. Lab facilities usually have tongs. If these are not available, barbecue tongs can be used. Alternately, a wooden spoon can be pushed through a milk carton. Students can safely hold this over the pot even when the container is filled with ice. Creative students may want to make their own. Check these designs for safety before allowing students to use them.

4. Test your design for safety before you attempt to distill your solution. Report any changes that you have to make.

   Answers will vary. This step was added to make students think about how to handle materials safely. A few practice runs before using the boiling water would be advised.

5. Evaluate your design and planning process. Be sure to give proof that your design worked.

   The methods described are not efficient. Students should recognize this fact. Some may come up with alternatives to increase their distillation efficiency.

   When compared to the original 5 mL sample saved, the solution in the pan will turn a darker colour as the distillate escapes. The second part of the proof is that the distillate is clear. If the distillate has been cooled and sterile equipment has been used, tasting can be a third way of proving the process works. The distillate is pure water. It will not taste salty.

   If students are encouraged to taste the distillate, emphasize that this is not a common practice in solution chemistry.

6. List three examples of how evaporation or distillation is used in nature, or by humans, to separate solutes from solutions.

   Answers will vary. Some examples are given.

   - *The water cycle depends on evaporation and condensation.*
   - *Salt water can be evaporated by people and/or nature to obtain the salt.*
   - *The oil industry uses fractionating towers to separate crude oil into its components (e.g. propane and butane).*
   - *Wet sand, grass, and dirt in the garden are dried by evaporation.*
   - *When you wash your bike and do not dry it, nature does it for you by evaporation.*

Section 2: Activity 3

The following are needed for this activity:

- the 5 mL coloured salt water solution from Activity 2
- hand lens is suggested
- sugar water
- lemon juice

1. Finish the story.

   Answers for this will vary. A few possible condensed endings follow.

   - *The house is haunted. When someone enters with greedy intentions that person turns into a precious stone. The room full of gems indicates that many greedy people had gained entrance to the room.*

- *The student collects the precious stones and becomes the wealthiest kid in the world. The student shares the wealth with friends and lives happily ever after.*

2. How can evaporation cause crystals to grow? Include the name of the process in your answer.

   As the solute is condensed by evaporation the solute particles join together in a regular pattern. The outside edges form flat surfaces.

Comment:

As a point of interest you may tell students that crystals from the same substance come in a variety of sizes. The shape of the crystals, whether large or small, remains the same.

3. Why does water from various places often taste different?

   Pure water is tasteless. Water gains its distinctive taste from the solutes it dissolves.

4. How does a kidney stone form?

   Kidney stones are formed in urine. Solute particles join together by the crystallization process. If the kidney stone is very large, medical attention is required.

5. Report your findings.

   Salt crystals are shaped like cubes. Dice have the same shape. The crystals will be the same colour as the dye that was used.

Section 2: Follow-up Activities

Extra Help

1. Complete the chart.

Separation Method	Explanation of How This Method Works
Settling	Heavy particles fall to the bottom of the container. Then the liquid is poured off.
Filtration	*The mixture is poured through a filter. Smaller particles pass through the filter. Larger particles are trapped by the filter.*
Evaporation	*A liquid turns from a liquid to a gas. The remainder of the mixture is left behind.*
Distillation	*A liquid is evaporated. The gas is condensed and collected. The remaining part (residue) can be collected following the distillation process.*
Crystallization	*As solutions evaporate, solute particles join together in regular patterns. The outside surfaces of the crystal are flat.*

2. Give an example of a mixture that you could separate using each of the methods indicated.

   Answers will vary. Sample answers are provided.

   a. Crystallization

      Sugar water could be separated by crystallization.

   b. Filtration

      Spaghetti and water can be separated by filtration using a colander.

   c. Settling

      Dirt and water can be separated by settling if the dirt particles are heavy enough.

   d. Distillation

      Baking soda and water could be separated by distillation.

e. Evaporation

Coffee and water can be separated by evaporation. Students that have washed coffee cups where all the water has evaporated from the mixture will be able to identify with this example. The stain left by the residue is not appealing.

Enrichment

You are the local town's environmental consultant. The town's drinking water has suddenly turned muddy, and you need to present to town council possible alternatives to remedy the problem. You were not asked to investigate the cost of each alternative. That is the responsibility of the engineering department. Town council has requested that you present at least three alternatives for review.

For each alternative, give the name of the separation process and how it could solve the muddy drinking water dilemma.

Answers will vary. A sample answer is given.

The water can be placed in a container. If the dirt particles are large enough, gravity will pull them to the bottom of the container. The process is called settling. The water can be drained off leaving the heavier mud particles behind.

If the water is not clean enough, it can be filtered by a process called filtration. The water is poured through a device that will not allow the mud particles through. Pure water can be obtained by distillation. In this process the water would be allowed to evaporate. The evaporated water would be collected and condensed.

Section 3: How Much Magic Can You Do?

Key concepts in this section are the following:

- variables
- concentration
- saturation point
- solubility
- graphing

This section has two parts. In the first part, students are introduced to the variables used in science inquiry. They use this new knowledge to study solubility informally. In the second part of the section, solubility terminology is presented. Students then study the effects of temperature on solute solubility. They are shown how to graph results to help process the data they collect. The intent of this section is to enhance the students' ability to design their own experiments.

Section 3: Activity 1

The following are needed for this activity:

- water
- three 250 mL beakers or identical glasses
- thermometer is suggested
- salt
- sugar

1. What are manipulated, responding, and controlled variables?

   Manipulated variables are experimental changes made by humans. Responding variables are nature's reaction to human manipulation. Controlled variables are factors that could change, but are not allowed to change during a scientific experiment.

2. In an inquiry experiment a scientist makes at least two trials. Why?

   In the first trial, nature is studied without human manipulation. In the second trial, a manipulation is made. Nature's response is studied. The second trial gives the scientist the ability to compare natural responses with manipulated responses.

3. What is the problem shown in the previous graphic? Use the "What effect does _____ have on _____ ?" format.

   What effect does heat have on the temperature of water?

4. What is the problem?

   What effect does the type of solute have on the amount of solute that can dissolve?

5. Write a prediction that answers the problem.

   Answers will vary, but some sample predictions are given.

   - *The type of solute will not affect the amount of solute that can dissolve.*
   - *More salt will dissolve in water than sugar.*
   - *More sugar will dissolve in water than salt.*

6. Write down an appropriate procedure to test your prediction. You will have to measure the amount of solute you add carefully. A tablespoon should be used to measure the solute and 100 mL of water should be used for each of the solutions.

   Answers will vary. A sample procedure follows.

   a. *Add a level tablespoon of salt to 100 mL of water. (The solute should be added gradually in portions of a tablespoon.)*

   b. *Stir until all of the salt is dissolved.*

   c. *Continue a. and b. until no more salt will dissolve.*

   d. *Record the amount of salt dissolved.*

   e. *Repeat a. through d. using sugar instead of salt. Make sure the temperature and the amount of water is the same in this second trial.*

Comment:

If a thermometer is not available for this experiment, have the student set out a container of water to reach room temperature. The temperature of the water will be approximately 20°C or similar to the thermostat reading.

7. Show your chart with your recordings entered.

Type of Solute	Amount of Solute Dissolved (tablespoons/100 mL)	Temperature
salt	1.5	20°C
sugar	2	20°C

8. Explain what your results demonstrated. Make sure to indicate whether your prediction was correct.

   Students should discover that water dissolves more sugar than salt at the temperature used (20°C).

Section 3: Activity 2

The following are needed for this activity:

- water
- thermometer (if possible)
- hot plate or stove
- three 250 mL beakers or identical glasses that can withstand hot water
- salt
- sugar
- spoon (about the size of a tablespoon)

1. Explain the meanings of concentration, saturation point, and solubility.

   Concentration is the measure of the amount of solute that is in a given amount of solvent. The saturation point is reached when no more solute can dissolve in a solvent. Solubility is a measure of the maximum amount of solute that will dissolve at the saturation point at a particular temperature.

2. How are you going to measure concentration in this module?

   In this module students will measure concentration by the number of tablespoons of solute in 100 mL of water.

3. Explain how solubility, concentration, and saturation point relate to the experiment you did in the last activity.

   Answers will vary. A sample follows.

   The concentration of the solute dissolved in water was increased until the saturation point was reached. At 20°C the solubility of salt in water was 1.5 tablespoons/100 mL of water. The solubility of sugar was 2 tablespoons/100 mL of water at the same temperature. Water at this temperature has a higher saturation point for sugar than for salt.

4. What are the similarities and differences between dissolving rate and solubility?

   Dissolving rate is the speed at which a solute dissolves, while solubility is the measure of the maximum amount of solute that will dissolve at a given temperature. Both terms relate to dissolving. Dissolving rate and solubility for most solutes increases with increasing temperature.

5. How can you use your knowledge of solubility to grow your own crystals?

   Answers can vary. One response follows.

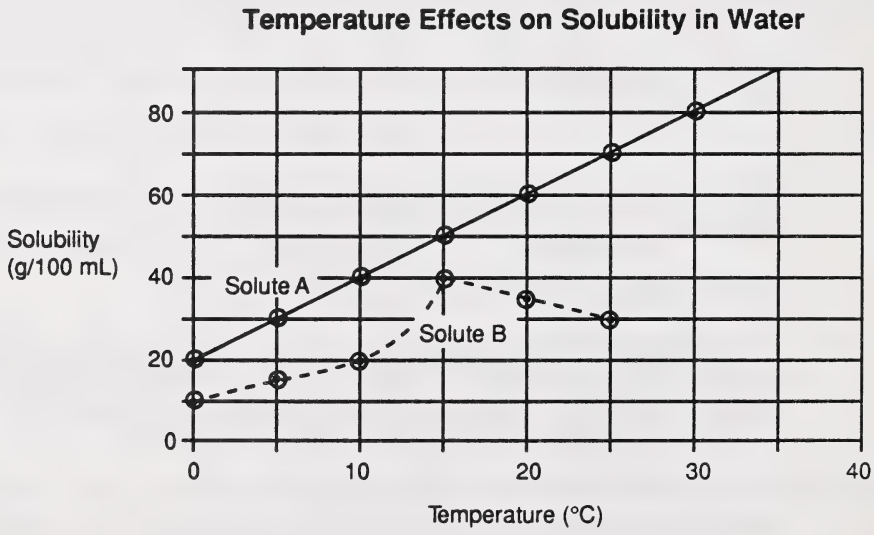
   Dissolve a solute in a hot solvent until the saturation point is reached. Tie a paper clip to a string. Attach the string to a pencil so that the paper clip is suspended in the solution. Allow the solution to cool. Crystals should form on the string. Crystals often grow very slowly, so allow plenty of time.

6. Use your graphing knowledge to complete the graph that follows.

   a. Determine and write in the label for the vertical axis.

      On the graph the vertical axis is reserved for the responding variable. The responding variable for this experiment is solubility. The units to be used for solubility are g /mL.

   b. Using the charts that follow, plot the remaining points for the two solubility curves. Draw a straight line or smooth curve to complete the solubility curves. Use a different colour for each solute.



   The student's extrapolation should be similar to the previous graph.

7. Write a hypothesis that answers the problem.

The information presented indicates that solubility increases when temperature is increased for most substances. If students use this information, their hypotheses will state that the solubilities for both sugar and salt will increase when water temperature is increased.

Comments:

- Students should be closely supervised for the experiment that follows. Hot materials are involved.
- Please note that for some students obtaining a suitable thermometer may be difficult. For this activity the solubility curves for salt and sugar are so different that students should estimate their temperatures as 25°C for cold, 70°C for warm, and 100°C for hot. The solubility trends can still be seen using these roughly estimated temperatures. However, it is preferable that students have the opportunity to measure temperature.

8. Record your data in the following charts.

Students may give solubilities to the nearest whole number of tablespoons. If the solute has been added gradually, students should be able to give a reliable estimate to the nearest one-half of a tablespoon. Although solubility values may vary, the trends shown in the following tables should be evident.

a.

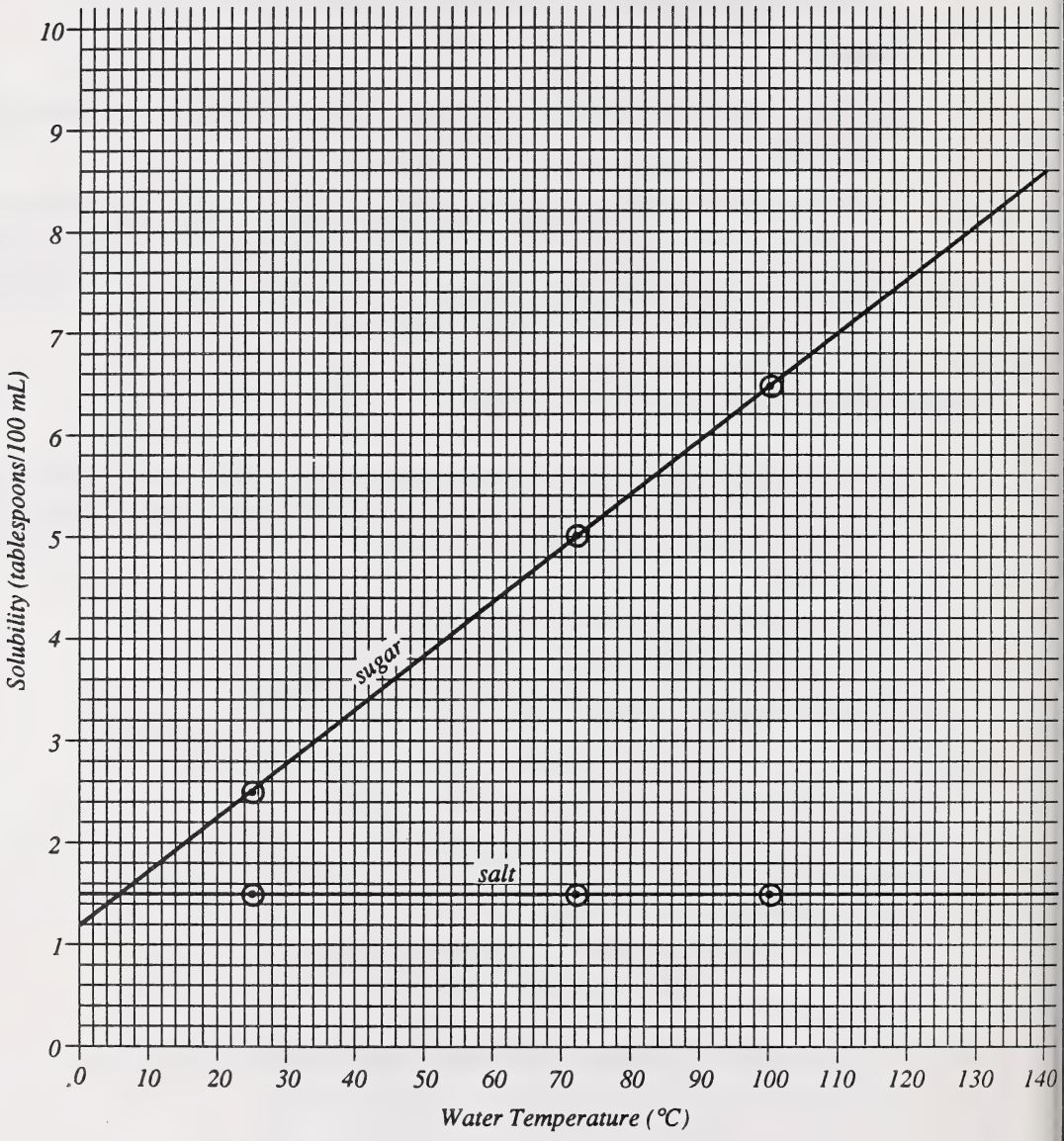
Water Temperature (°C)	Solubility of Salt (tablespoons/100 mL)
25	*1.5*
72	*1.5*
100	*1.5*

b.

Water Temperature (°C)	Solubility of Sugar (tablespoons/100 mL)
25	*2.5*
72	*5.0*
100	*6.5*

9. Use your charts to construct two curves on the following graph. Label each curve.

Title: *Effect of Temperature on Salt and Sugar Solubility*



10. Explain what your graph tells you about the solubilities of the two solutes you experimented with.

The solubility of salt only increases about 4 g /100 mL between 0 and 100°C. A tablespoon measurement will not show a change this small. Student graphs for salt will be either a horizontal line or a line quite similar to that. Sugar's solubility changes significantly with temperature increases. Student graphs should show the sugar solubility curve rising quite rapidly to the right side of their graph paper. At low temperatures the solubility of sugar and salt is similar.

Section 3: Follow-up Activities

Extra Help

Water Temperature (°C)	Solubility of Potassium Chloride (g/100 mL)
10	31
20	34
30	37
40	40

Use the preceding chart to answer the following questions.

1. What is the solubility of potassium chloride at 30°C? Be sure to include solubility units and temperature.

The solubility of potassium chloride is 37 g /100 mL at 30°C.

2. Give an example of a concentration for potassium chloride that has not reached the saturation point. Be sure to include solubility units and temperature.

The answers will vary. The concentration must be less than the solubility for the temperature. For example, at 10°C any concentration less than 31 g/100 mL is correct. At 20°C any concentration less than 34 g/100 mL is correct.

Refer to the solubility chart for potassium chloride to answer the following questions.

3. What are the manipulated and responding variables shown?

   On the potassium chloride chart the manipulated variable is the temperature, and the responding variable is the solubility of potassium chloride.

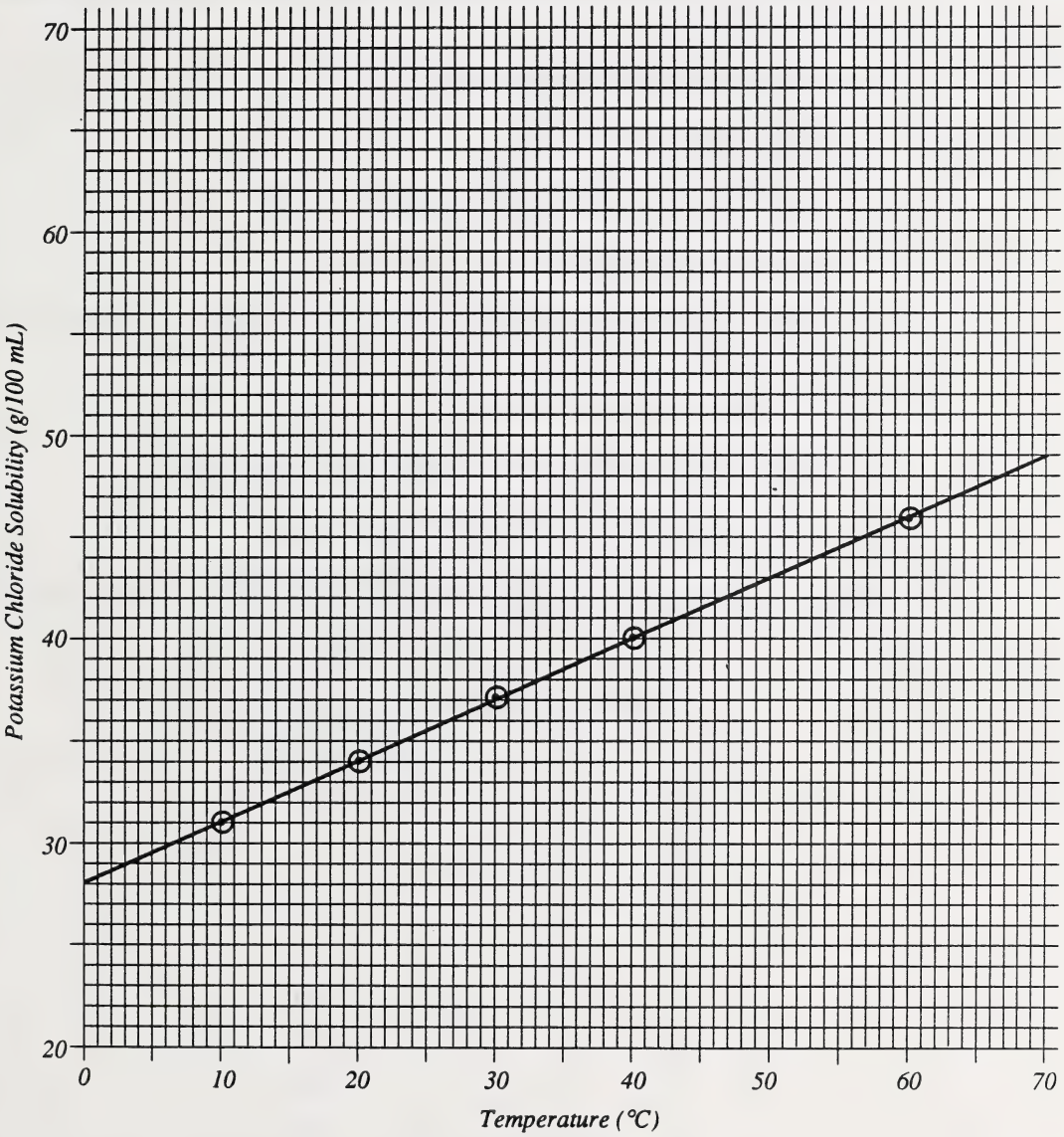
4. What controlled variable is very important to consider in determining temperature's effect on the solubility of potassium chloride?

   Since solubility is measured by the amount of solute per 100 mL, the amount of water used in each trial must be the same.

5. Using these graphing rules and the data table, complete the following graph.

Water Temperature (°C)	Solubility of Potassium Chloride (g/100 mL)
10	31
20	34
30	37
40	40

Title: *Solubility of Potassium Chloride at Different Temperatures*



Enrichment

1. In this section you made a graph following a set of rules. What were the rules you had to follow to graph your data?

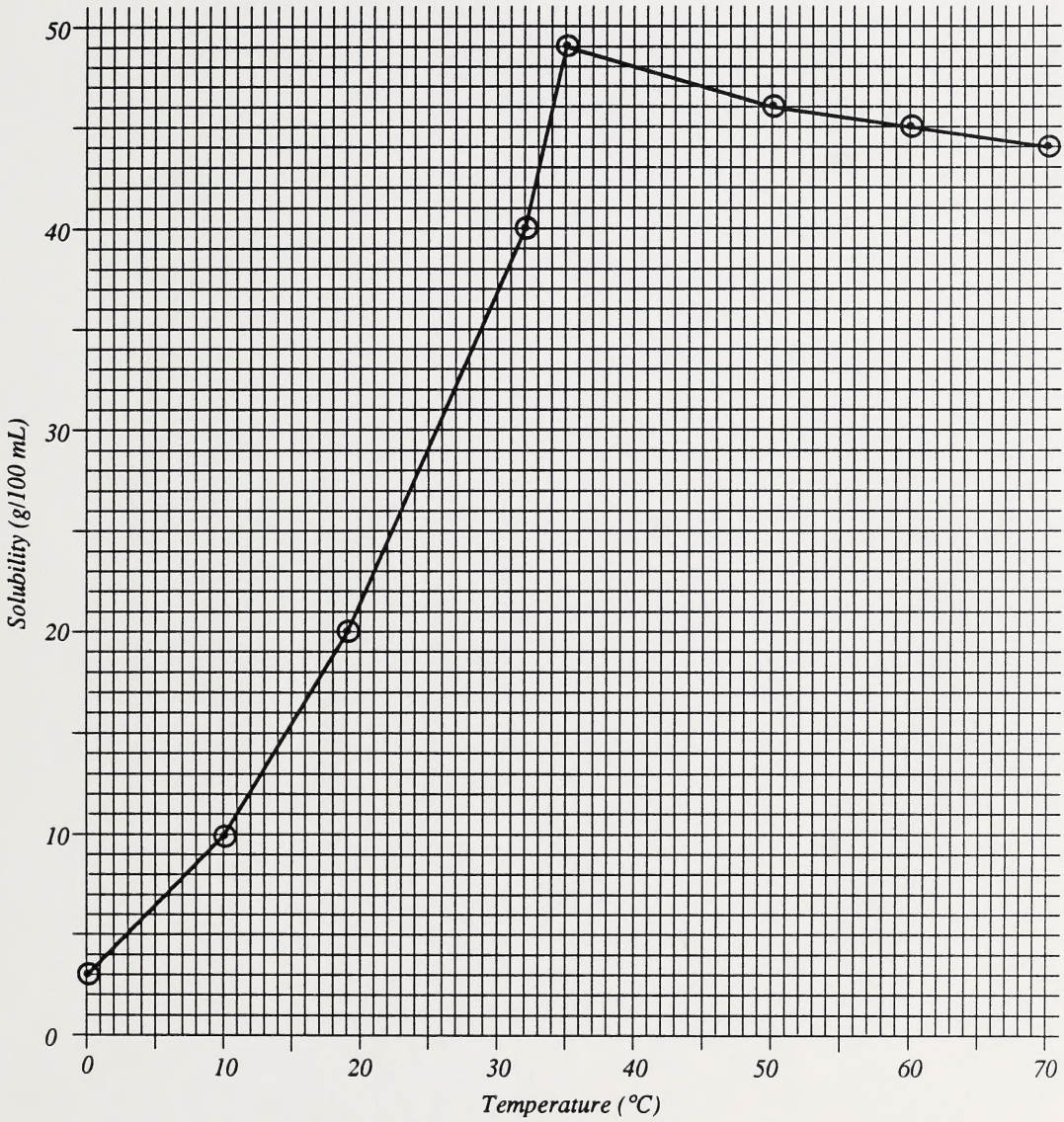
   Answers will vary. A sample answer follows.

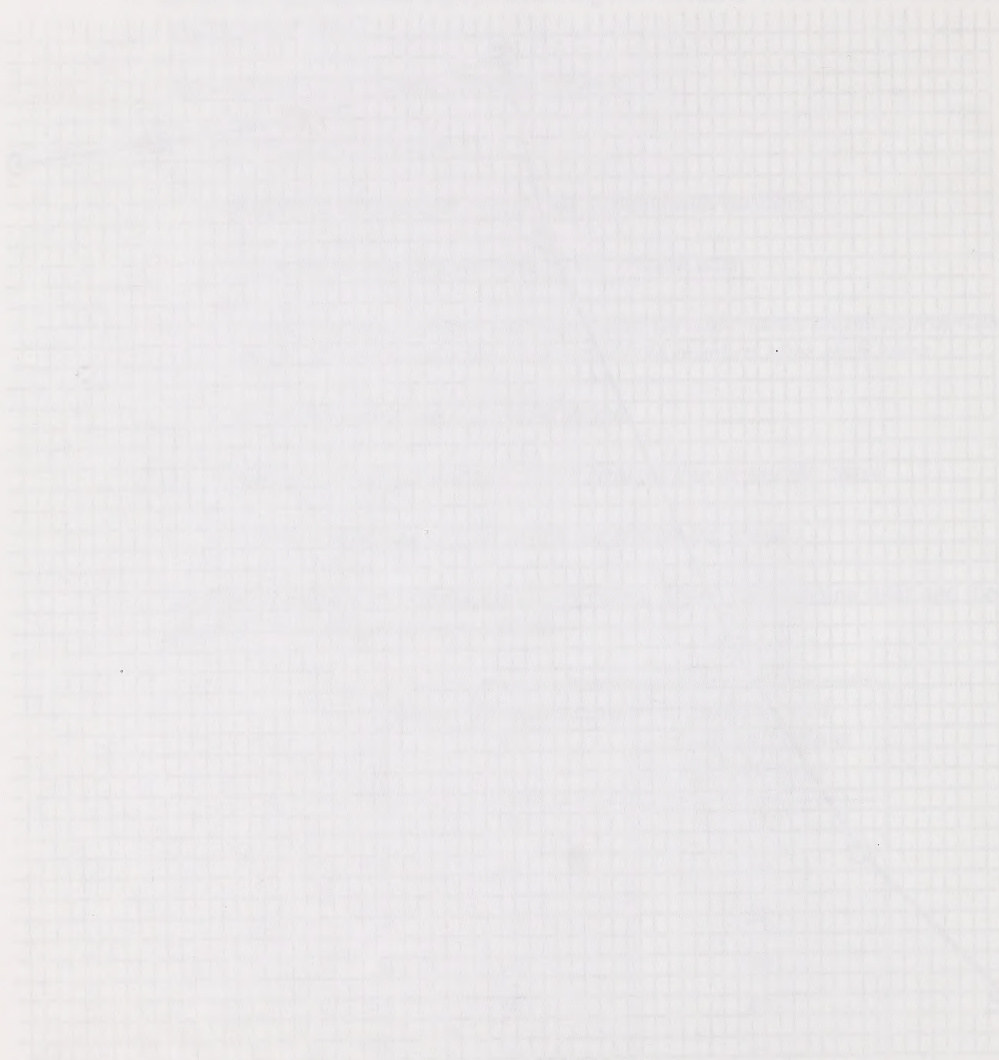
   - *Give the graph a title.*
   - *Reserve the horizontal axis for the manipulated variable.*
   - *Place the responding variable on the vertical axis.*
   - *Include the manipulated and responding variable names on the appropriate axis of the graph. Write the units for each variable in brackets after each name.*
   - *Circle the points you plot on the graph.*
   - *Connect the points you plot with a straight line or smooth curve.*
   - *Cover at least half of your graph paper with the graph.*

2. Sodium sulfate has an unusual solubility curve. Using the graphing rules and the data table, graph the solubility of sodium sulfate.

Water Temperature (°C)	Solubility of Sodium Sulfate (g/100 mL)
0	3
10	10
19	20
32	40
35	49
50	46
60	45
70	44

Title: *Solubility of Sodium Sulfate at Different Temperatures*





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